	Document ID	Issue Date	Pages	Title	Current OR	Current XRef
1	US 6177245 B1	20010123	45	Manipulation of protoporphyrinogen oxidase enzyme activity in eukaryotic organisms	435/6	536/23.1 ; 536/24.3 ; 536/24.31 ; 536/24.32
2	US 6084155 A	20000704		Herbicide-tolerant protoporphyrinogen oxidase ("protox") genes	800/300	435/320.1 ; 435/419 ; 435/440 ; 536/23.2 ; 536/23.6 ; 800/306 ; 800/312 ; 800/314 ; 800/317.3 ; 800/320 ; 800/320.1 ; 800/320.2 ; 800/320.3
3	US 6023012 A	20000208		DNA molecules encoding plant protoporphyrinogen oxidase	800/300	
4	US 6018105 A	20000125		Promoters from plant protoporphyrinogen oxidase genes	800/298	435/320.1 ; 435/419 ; 536/24.1
5	US 5939602 A	19990817		DNA molecules encoding plant protoporphyrinogen oxidase and inhibitor-resistant mutants thereof	800/300	435/320.1 ; 435/419 ; 435/440 ; 435/468 ; 536/23.2 ; 536/23.6 ; 800/278

	Document ID	Issue Date	Pages	Title	Current OR	Current XRef
6	US 5767373 A	19980616		Manipulation of protoporphyrinogen oxidase enzyme activity in eukaryotic organisms	800/300	435/418 ; 435/419 ; 435/69.1 ; 536/23.6 ; 800/298 ; 800/300.1 ; 800/306 ; 800/312 ; 800/314 ; 800/317.3
7	WO 9833927 A1	20000221		New genetically transformed, herbicide-resistant plants - containing chimeric gene encoding protoporphyrinogen oxidase to confer resistance to porphyrin biosynthesis inhibition by herbicide		
8	US 5939602 A	19990817		New DNA encoding plant proto:porphyrinogen oxidase enzyme - and herbicide resistant mutants, useful to prepare plants resistant to herbicide which therefore kills		

	Document ID	Issue Date	Pages	Title	Current OR	Current XRef
9	EP 770682 A3	19980601		Herbicide-tolerant transgenic plants, especially tobacco, contain proto:phyrinogen oxidase gene - resistant to di:phenyl:ether-derived herbicide		

	L #	Hits	Search Text	DBs	Time Stamp
1	L6	83	protoporphyrinogen adj oxidase	USPAT; EPO; JPO; DERWENT	2001/07/23 10:53
2	L11	68	16 and herbicid$	USPAT; EPO; JPO; DERWENT	2001/07/23 10:53
3	L16	9	111 and tobacco	USPAT; EPO; JPO; DERWENT	2001/07/23 10:53

(FILE 'HOME' ENTERED AT 10:20:01 ON 23 JUL 2001)

FILE 'MEDLINE, AGRICOLA, CAPLUS, BIOSIS, EMBASE, WPIDS' ENTERED AT
10:20:11 ON 23 JUL 2001

L1 1231 S PROTOX OR(PROTOPORPHYRINOGEN (W) OXIDASE) OR PROTOPORPHYRINOG
L2 4319899 S L1 AND HERBIC? OR INHIBIT?
L3 743 S L1 AND (HERBIC? OR INHIBIT?)
L4 385 DUP REM L3 (358 DUPLICATES REMOVED)
L5 215 S L4 NOT PY>1997

FILE 'STNGUIDE' ENTERED AT 10:26:58 ON 23 JUL 2001

FILE 'MEDLINE, AGRICOLA, CAPLUS, BIOSIS, EMBASE, WPIDS' ENTERED AT
10:44:06 ON 23 JUL 2001

L6 16 S L5 AND (HERBICID? (W) RESISTANCE)
L7 37 S L5 AND (RESISTAN? OR TOLERAN?)

L7 ANSWER 1 OF 37 MEDLINE
ACCESSION NUMBER: 96003760 MEDLINE
DOCUMENT NUMBER: 96003760 PubMed ID: 7575589
TITLE: Generation of **resistance** to the diphenyl ether **herbicide** acifluorfen by MEL cells.
AUTHOR: Prasad A R; Dailey H A
CORPORATE SOURCE: Department of Microbiology, University of Georgia, Athens 30602-2605, USA.
CONTRACT NUMBER: DK32303 (NIDDK)
DK35898 (NIDDK)
SOURCE: BIOCHEMICAL AND BIOPHYSICAL RESEARCH COMMUNICATIONS, (1995 Oct 4) 215 (1) 186-91.
Journal code: 9Y8; 0372516. ISSN: 0006-291X.
PUB. COUNTRY: United States
Journal; Article; (JOURNAL ARTICLE)
LANGUAGE: English
FILE SEGMENT: Priority Journals
ENTRY MONTH: 199511
ENTRY DATE: Entered STN: 19951227
Last Updated on STN: 19970203
Entered Medline: 19951109

AB The diphenyl ether **herbicide** acifluorfen has been shown to act by **inhibition** of the terminal enzyme of the protoporphyrin biosynthetic pathway, **protoporphyrinogen oxidase** (E.C. 1.3.3.4) (PPO), in plant and animal cells. In the present study we show that long term maintenance of murine erythroleukemia (MEL) cells in acifluorfen, which is normally toxic to these cells at 5 microM concentration, results in cells that grow at a near normal rate in 100 microM acifluorfen. Acifluorfen **resistant** cells do not have increased levels of PPO activity, nor does the PPO made by these cells have increased **resistance** to acifluorfenin, but these cells accumulate porphyrin and have elevated levels of heme. Data is presented that suggests the **resistance** of these MEL cells to acifluorfen may be attributable to induction of a cytochrome P450(s).

L7 ANSWER 2 OF 37 AGRICOLA
ACCESSION NUMBER: 1999:30195 AGRICOLA
DOCUMENT NUMBER: IND21975722
TITLE: Soybean (Glycine max) cultivar differences in response to sulfentrazone.
AUTHOR(S): Dayan, F.E.; Weete, J.D.; Duke, S.O.; Hancock, H.G.
CORPORATE SOURCE: USDA, ARS, Southern Weed Science Laboratory, Stoneville, MS.
AVAILABILITY: DNAL (79.8 W41)
SOURCE: Weed science, Sept/Oct 1997. Vol. 45, No. 5. p. 634-641
Publisher: Lawrence, KS : Weed Science Society of America.
CODEN: WEESA6; ISSN: 0043-1745
NOTE: Includes references
PUB. COUNTRY: Kansas; United States
DOCUMENT TYPE: Article
FILE SEGMENT: U.S. Imprints not USDA, Experiment or Extension
LANGUAGE: English

AB Greenhouse-grown soybean cultivars varied in their **tolerance** to preemergence application of sulfentrazone. The cultivars Ransom, Hutcheson, Kato, Gasoy 17, and Cobb exhibited relatively low **tolerance** to 0.5 kg ai ha-1 sulfentrazone with 38, 41, 46, 50, and 58% height reduction compared to respective controls. The growth of **tolerant** cultivars Centennial, Edison, and Hartz 5164 was not affected by this treatment. However, the growth of all cultivars was reduced at the excessive rate of 2.0 kg ha-1 preemergence application of sulfentrazone. No differences in root uptake or translocation of [14C] sulfentrazone were observed between the relatively **tolerant** and less **tolerant** cultivars tested. Centennial and Hutcheson cultivars rapidly metabolized sulfentrazone via oxidative degradation of the 3-methyl group on the triazolinone ring of the **herbicide**. Only 4.7 and 4.9% of the active ingredient remained in the foliage of Hutcheson and Centennial 24 h after treatment, respectively. While there were no differences in **Protox inhibition** or Proto IX accumulation between the two cultivars, Hutcheson was more sensitive than Centennial to peroxidative stresses induced by either Proto IX accumulation or rose bengal. Therefore, **tolerance** to sulfentrazone is due to rapid metabolism of the **herbicide**; however, the intraspecific difference in response to sulfentrazone appears to be due to intrinsic differential **tolerance** to the **herbicide**-induced peroxidative stress.

L7 ANSWER 3 OF 37 AGRICOLA
ACCESSION NUMBER: 1998:47965 AGRICOLA
DOCUMENT NUMBER: IND21240740
TITLE: Effects of isoxazole **herbicides** on **protoporphyrinogen oxidase** and porphyrin physiology.
AUTHOR(S): Dayan, F.E.; Duke, S.O.; Reddy, K.N.; Hamper, B.C.; Leschinsky, K.L.
AVAILABILITY: DNAL (381 J8223)
SOURCE: Journal of agricultural and food chemistry, Mar 1997. Vol. 45, No. 3. p. 967-975
Publisher: Washington, D.C. : American Chemical Society.
CODEN: JAFCAU; ISSN: 0021-8561
NOTE: Includes references
PUB. COUNTRY: District of Columbia; United States
DOCUMENT TYPE: Article
FILE SEGMENT: U.S. Imprints not USDA, Experiment or Extension
LANGUAGE: English
AB The biochemical and physiological effects of 10 isoxazoles were investigated. The amount of protoporphyrin IX caused to accumulate by the compounds correlated well with their **herbicidal** activity. **Protoporphyrinogen oxidase** (**Protox**) was **inhibited** competitively in the proximity of the catalytic site. However, the **Protox** I50 values of the methyl esters and acid chloride derivatives were lower than expected on the basis of their in vivo **herbicidal** activity. The results suggest that some **tolerance** mechanism, other than differential absorption and translocation, may protect the plants against these compounds. The molecular properties of 9 isoxazoles and 2 other well-known **inhibitors** of different **herbicide** groups were compared to those of protoporphyrinogen (Protogen). The most active compounds have similar bulk, electronic, and energy properties that approximate half of the Protogen molecule. Furthermore, these compounds have atoms/groups on the ring that generate distinct negative electrostatic potential fields that may mimic the reactive part of the Protogen molecule.

L7 ANSWER 4 OF 37 AGRICOLA
ACCESSION NUMBER: 1998:24394 AGRICOLA
DOCUMENT NUMBER: IND20627869
TITLE: Mechanisms of **resistance** to **protoporphyrinogen oxidase-inhibiting herbicides.**
AUTHOR(S): Duke, S.O.; Lee, H.J.; Duke, M.V.; Reddy, K.N.; Sherman, T.D.; Becerril, J.M.; Nandihalli, U.B.; Matsumoto, H.; Jacobs, N.J.; Jacobs, J.M.
AVAILABILITY: DNAL (SB951.4.W45 1997)
SOURCE: [Weed and crop resistance to herbicides], p. 155-160
Publisher: Dordrecht ; Boston, Mass. : Kluwer Academic, 1997.
ISBN: 0792345819 (alk. paper).
NOTE: Paper based on a lecture presented at the International Symposium on Weed and Crop **Resistance** to **Herbicides**, April, 1995, Cordoba, Spain. Edited by R. De Prado, J. Jorrin and L. Garcia-Torres.
Includes references
PUB. COUNTRY: Netherlands
DOCUMENT TYPE: Article; Conference
FILE SEGMENT: Non-U.S. Imprint other than FAO
LANGUAGE: English

L7 ANSWER 5 OF 37 AGRICOLA
ACCESSION NUMBER: 97:18349 AGRICOLA
DOCUMENT NUMBER: IND20551638
TITLE: Protoporhyrinogen destruction by plant extracts and correlation with **tolerance** to **protoporphyrinogen oxidase-inhibiting herbicides.**
AUTHOR(S): Jacobs, J.M.; Jacobs, N.J.; Duke, S.O.
CORPORATE SOURCE: Dartmouth Medical School, Hanover, NH.
SOURCE: Pesticide biochemistry and physiology, May 1996. Vol. 55, No. 1. p. 77-83
Publisher: Orlando, Fla. : Academic Press.
CODEN: PCBPBS; ISSN: 0048-3575
NOTE: Includes references
PUB. COUNTRY: Florida; United States
DOCUMENT TYPE: Article
FILE SEGMENT: U.S. Imprints not USDA, Experiment or Extension

LANGUAGE: English
AB **Herbicidal** damage by photobleaching diphenylether **herbicides** is the indirect result of **inhibition** of an enzyme in chlorophyll biosynthesis. The substrate of the **inhibited** enzyme, protoporphyrinogen, accumulates and is subsequently converted to protoporphyrin, a potent photoactive compound which causes light-dependent membrane damage. In the present study, we report characteristics of a factor in the soluble fraction of leaves which can decompose protoporphyrinogen to nonporphyrin products. This process may be important in protecting plants from **herbicide** damage, since it would interfere with accumulation of the phototoxic porphyrin, protoporphyrin. We found that this protoporphyrinogen destruction is associated with the protein fraction of the soluble leaf homogenate, suggesting its enzymatic nature. Protoporphyrinogen destruction is stable to mild heat, but is eliminated by boiling. Protoporphyrinogen destruction is present in the soluble leaf homogenate but is not localized within the stromal fraction of the chloroplast. The reductants dithiothreitol and beta-mercaptoethanol, but not glutathione, **inhibit** protoporphyrinogen destruction at high concentrations. In contrast, ascorbic acid markedly **inhibits** destruction even at low concentrations, suggesting a role for cellular ascorbic acid in protecting protoporphyrinogen from destruction, thereby enhancing **herbicide** action. Protoporphyrinogen destruction was least active in young cucumber leaves, a plant highly susceptible to **herbicides**. Higher levels of protoporphyrinogen destruction were found in leaves of broadleaf mustard and radish, two plants exhibiting **herbicide tolerance**. For cucumber, the extent of destruction increased with the age of the plant. These findings suggest a correlation between increased protoporphyrinogen destruction and **herbicide tolerance** in some plant species.

L7 ANSWER 6 OF 37 AGRICOLA
ACCESSION NUMBER: 96:36352 AGRICOLA
DOCUMENT NUMBER: IND20517474
TITLE: An endoplasmic reticulum plant enzyme has **protoporphyrinogen IX oxidase** activity.
AUTHOR(S): Retzlaff, K.; Boger, P.
CORPORATE SOURCE: Universitat Konstanz, Konstanz, Germany.
AVAILABILITY: DNAL (SB951.P49)
SOURCE: Pesticide biochemistry and physiology, Feb 1996. Vol. 54, No. 2. p. 105-114
Publisher: Orlando, Fla. : Academic Press.
CODEN: PCBPBS; ISSN: 0048-3575
NOTE: Includes references
PUB. COUNTRY: Florida; United States
DOCUMENT TYPE: Article
FILE SEGMENT: U.S. Imprints not USDA, Experiment or Extension
LANGUAGE: English
AB **Protoporphyrinogen IX oxidase** is **inhibited** by peroxidizing **herbicides**, resulting in the accumulation of protoporphyrin IX. The mechanism of protoporphyrin IX formation is unclear. We found a decrease in protoporphyrin IX in intact corn and cucumber etioplasts with increasing **herbicide** concentrations, which suggests an extraplastidic mechanism may be involved in forming protoporphyrin IX in **herbicide**-treated plants. Since a microsomal fraction from etiolated corn seedlings showed a substantial protoporphyrinogen IX oxidizing enzyme activity, the endoplasmic reticulum (ER) from this fraction was purified. Apparent Km and Vmax values of the ER enzyme for protoporphyrinogen IX were similar to the values reported for **protox** from corn thylakoids. The ER enzyme activity, however, was more sensitive to reductants like dithiothreitol than the plastidic enzyme activity and exhibited a higher **tolerance** toward various peroxidizing **herbicides**. Accordingly, the ER enzyme may oxidize protoporphyrinogen IX in the presence of **herbicide** concentrations, which **inhibit** the plastidic and mitochondrial **protoporphyrinogen IX oxidase**. Apparently the ER enzyme is instrumental in the phytotoxic accumulation of protoporphyrin IX in **herbicide**-treated plants.

L7 ANSWER 7 OF 37 AGRICOLA
ACCESSION NUMBER: 96:30398 AGRICOLA
DOCUMENT NUMBER: IND20513576
TITLE: **Protoporphyrinogen oxidase** as the optimal **herbicide** site in the porphyrin pathway.
AUTHOR(S): Duke, S.O.; Nandihalli, U.B.; Lee, H.J.; Duke, M.V.
CORPORATE SOURCE: Southern Weed Science Laboratory, Stoneville, MS.

AVAILABILITY: DNAL (QD1.A45)
SOURCE: ACS symposium series, 1994. No. 559. p. 191-204
Publisher: Washington, D.C. : American Chemical Society, 1974-
CODEN: ACSMC8; ISSN: 0097-6156
NOTE: In the series analytic: Porphyric pesticides: chemistry, toxicology and pharmaceutical applications / edited by S.O. Duke and C.A. Reheiz.
Includes references
PUB. COUNTRY: District of Columbia; United States
DOCUMENT TYPE: Article; Law
FILE SEGMENT: U.S. Imprints not USDA, Experiment or Extension
LANGUAGE: English

AB **Herbicide** discovery efforts have yielded a large number of excellent **herbicides** that target the porphyrin pathway. **Protoporphyrinogen oxidase** (**Protox**) is the only molecular site **inhibited** by the commercially available members of this **herbicide** class. We hypothesize that this site of action is much better for **herbicidal** activity than other sites of the porphyrin pathway because of the location of **herbicide**-susceptible **Protox** within the cell (the plastid envelope and the mitochondrion), the existence of a **herbicide-resistant** form of the enzyme in the plasma membrane (which rapidly causes accumulation of protoporphyrin IX when plastic **Protox** is **inhibited**), and two chemical features of the substrate (its relatively low lipophilicity and its non-planar macrocycle). Although enzymes of the porphyrin pathway beyond **Protox** can be **inhibited** to cause the accumulation of phytotoxic levels of porphyrins, these sites do not share the unique properties of **Protox**. As a result, the number of active analogues that effectively **inhibit** these enzymes in vivo is much smaller than for **Protox**, and the amount of **herbicide** needed for effective **herbicidal** action is relatively higher.

L7 ANSWER 8 OF 37 AGRICOLA
ACCESSION NUMBER: 96:30395 AGRICOLA
DOCUMENT NUMBER: IND20513573
TITLE: Mechanisms of plant **tolerance** to photodynamic **herbicides**.
AUTHOR(S): Komives, T.; Gullner, G.
CORPORATE SOURCE: Hungarian Academy of Science, Budapest, Hungary.
AVAILABILITY: DNAL (QD1.A45)
SOURCE: ACS symposium series, 1994. No. 559. p. 177-190
Publisher: Washington, D.C. : American Chemical Society, 1974-
CODEN: ACSMC8; ISSN: 0097-6156
NOTE: In the series analytic: Porphyric pesticides: chemistry, toxicology and pharmaceutical applications / edited by S.O. Duke and C.A. Reheiz.
Includes references
PUB. COUNTRY: District of Columbia; United States
DOCUMENT TYPE: Article; Law
FILE SEGMENT: U.S. Imprints not USDA, Experiment or Extension
LANGUAGE: English

AB Phytotoxicity of photodynamic **herbicides** is the result of a highly complicated set of biochemical and biophysical reactions, elements of which may play significant roles in promoting or antagonizing tissue damage. Plant **tolerance** is primarily influenced by the ability of the plant to escape deleterious concentrations of the **herbicide** and the active oxygen species that are generated in treated tissues. The key role of the glutathione-conjugation system in the metabolic detoxication of nitrodiphenyl ether **herbicides** and the importance of the antioxidant systems to counteract photodynamic damage in several **tolerant** plants have been clearly established. Levels of accumulated protoporphyrin IX following **protoporphyrinogen IX oxidase inhibition** are as important in determining selective photodynamic toxicity as the ability of the **herbicide** to **inhibit** the enzyme.

L7 ANSWER 9 OF 37 AGRICOLA
ACCESSION NUMBER: 96:30334 AGRICOLA
DOCUMENT NUMBER: IND20513496
TITLE: Variation in crop response to **protoporphyrinogen oxidase inhibitors**.
AUTHOR(S): Matsumoto, H.; Lee, J.J.; Ishizuka, K.
CORPORATE SOURCE: University of Tsukuba, Ibaraki, Japan.
AVAILABILITY: DNAL (QD1.A45)
SOURCE: ACS symposium series, 1994. No. 559. p. 120-132

Publisher: Washington, D.C. : American Chemical Society, 1974-
CODEN: ACSMC8; ISSN: 0097-6156
NOTE: In the series analytic: Porphyric pesticides: chemistry, toxicology and pharmaceutical applications / edited by S.O. Duke and C.A. Reheiz.
Includes references
PUB. COUNTRY: District of Columbia; United States
DOCUMENT TYPE: Article; Law
FILE SEGMENT: U.S. Imprints not USDA, Experiment or Extension
LANGUAGE: English
AB **Tolerance** of nine plant species to diphenyl ether (DPE) **herbicides** oxyfluorfen and chlomethoxyfen were tested in vivo. There was considerable variation in **tolerance** to the **herbicides** between the species. Although both **herbicides** cause photodynamic damage as a result of **protoporphyrinogen oxidase** (**Protox**) **inhibition**, resulting in abnormally high levels of protoporphyrin IX (Proto IX) accumulation, there is little information on the reasons for differential interspecific **tolerance** to the **herbicides**. We compare uptake, movement and metabolism, Proto IX accumulation in vivo, **Protox inhibition** in vitro, and activities of antioxidative systems between the species to investigate the physiological basis of differential **tolerance** to two diphenyl ethers. Our findings suggest that differential **tolerance** of the species examined in this study is mainly due to differences in rates of **herbicides** absorption, Proto IX accumulation, and intrinsic antioxidative activity.

L7 ANSWER 10 OF 37 AGRICOLA
ACCESSION NUMBER: 96:30330 AGRICOLA
DOCUMENT NUMBER: IND20513492
TITLE: Characterization of a mutant of Chlamydomonas reinhardtii **resistant** to **protoporphyrinogen oxidase inhibitors.**
AUTHOR(S): Sato, R.; Yamamoto, M.; Shibata, H.; Oshio, H.; Harris, E.H.; Gillham, N.W.; Boynton, J.E.
CORPORATE SOURCE: Duke University, Durham, NC.
AVAILABILITY: DNAL (QD1.A45)
SOURCE: ACS symposium series, 1994. No. 559. p. 91-104
Publisher: Washington, D.C. : American Chemical Society, 1974-
CODEN: ACSMC8; ISSN: 0097-6156
NOTE: In the series analytic: Porphyric pesticides: chemistry, toxicology and pharmaceutical applications / edited by S.O. Duke and C.A. Reheiz.
Includes references
PUB. COUNTRY: District of Columbia; United States
DOCUMENT TYPE: Article; Law
FILE SEGMENT: U.S. Imprints not USDA, Experiment or Extension
LANGUAGE: English
AB A nuclear mutant of Chlamydomonas reinhardtii (rs-3) is **resistant** to several **herbicides** which **inhibit** the enzyme ***protoporphyrinogen oxidase*** (**Protox**) in plants, including S-23142 [N-(4-chloro-2-fluoro-5-propargyloxy)-phenyl-3,4,5,6-tetrahydrophthalimide], acifluorfenethyl, oxyfluorfen, and oxadiazon. **Protox** enzyme activity in Percoll-purified chloroplast thylakoids from rs-3 is less sensitive to S-23142 than that from wild type, indicating that the rs-3 mutation either directly or indirectly confers **resistance** on the enzyme. Genetic analysis of rs-3 showed that **resistance** results from a single dominant nuclear mutation that maps to linkage group IX, 13.7 and 12.3 map units from sr-1 and pf-16 respectively. Efforts to identify the **resistance** gene from a cosmic library of rs-3 nuclear DNA by transformation have yielded one S-23142 **resistant** isolate from the cell wall-less arginine-requiring strain CC-425 (arg-2, cw-15). Since no isolates **resistant** to S-23142 were seen in control experiments, this suggests that the **resistant** isolate is a transformant and that the rs-3 gene can be isolated by screening individual cosmic clones by transformation.

L7 ANSWER 11 OF 37 AGRICOLA
ACCESSION NUMBER: 96:30284 AGRICOLA
DOCUMENT NUMBER: IND20513446
TITLE: Porphyrin biosynthesis as a tool in pest management: an overview.
AUTHOR(S): Duke, S.O.; Rebeiz, C.A.
CORPORATE SOURCE: Southern Weed Science Laboratory, ARS, USDA, Stoneville, MS.

AVAILABILITY: DNAL (QD1.A45)
SOURCE: ACS symposium series, 1994. No. 559. p. 1-16
Publisher: Washington, D.C. : American Chemical Society, 1974-
CODEN: ACSMC8; ISSN: 0097-6156
NOTE: In the series analytic: Porphyric pesticides: chemistry, toxicology and pharmaceutical applications / edited by S.O. Duke and C.A. Reheiz.
Includes references
PUB. COUNTRY: District of Columbia; United States
DOCUMENT TYPE: Article; Law
FILE SEGMENT: U.S. Imprints not USDA, Experiment or Extension
LANGUAGE: English

AB Porphyrin biosynthesis can be manipulated chemically in pests to cause accumulation of sufficient photodynamic porphyrin intermediates for pesticidal activity. Chemicals used for this purpose are: delta-aminolevulinic acid (ALA, a porphyrin precursor); **protoporphyrinogen oxidase** (**Protox**) **inhibitors**; and modulators of the heme and chlorophyll biosynthetic pathways such as 2,2'-dipyridyl and 1,10-phenanthroline. A wide array of **Protox inhibitors** (**herbicides**) are commercially available, while ALA-based applications are still in the experimental stage. **Protox inhibitors** cause the accumulation of protoporphyrin IX and other porphyrins in plants via a complex mechanism. No weeds have thus far evolved **resistance** to **herbicides** with this mechanism of action. However, some plant species have natural **tolerance** to such **herbicides** by a variety of mechanisms. **Protox inhibitors** are apparently ineffective on insects; however, ALA and modulators of the heme pathway have insecticidal activity. Porphyrinogenic compounds such as ALA have been used or patented for use in photodynamic therapy, and as **herbicides**. The commercialization of ALA-based photodynamic **herbicides** will depend, however, on the success of efforts directed at translating successful greenhouse applications to field use. **Protox inhibitors** have been patented as pharmaceutical for treatment of disorders of the heme pathway. **Protox inhibitor herbicides** have been found to cause accumulation of certain porphyrins in non-target animals, although porphyria has not been reported.

L7 ANSWER 12 OF 37 AGRICOLA
ACCESSION NUMBER: 95:65492 AGRICOLA
DOCUMENT NUMBER: IND20484852
TITLE: Protoporphyrinogen IX-oxidizing activites involved in the mode of action of peroxidizing **herbicides**
.
AUTHOR(S): Lee, H.J.; Duke, S.O.
CORPORATE SOURCE: Southern Weed Science Laboratory, ARS, USDA, Stoneville, MS.
AVAILABILITY: DNAL (381 J8223)
SOURCE: Journal of agricultural and food chemistry, Nov 1994. Vol. 42, No. 11. p. 2610-2618
Publisher: Washington, D.C. : American Chemical Society.
CODEN: JAFCAU; ISSN: 0021-8561
NOTE: Includes references
PUB. COUNTRY: District of Columbia; United States
DOCUMENT TYPE: Article
FILE SEGMENT: U.S. Imprints not USDA, Experiment or Extension
LANGUAGE: English

AB A plasma membrane (PM)-associated **protoporphyrinogen oxidase** (**Protox**)-like activity has recently been hypothesized to play a critical role in the oxidation of protoporphyrinogen IX exported by **Protox-inhibited** plastids to protoporphyrin IX in acifluorfen-methyl-treated plant tissues. **Protox** activities from etioplast and PM fractions from 7-day-old etiolated barley leaves were compared with regard to susceptibility to several **Protox-inhibiting herbicides**, effects of NADPH, quinones, and chelators, and other biochemical parameters. Etioplast **Protox** was much more susceptible to the **herbicides** than was PM **Protox**, whereas PM activity was much more **inhibited** by dithiothreitol (DTT). Cross-contamination could account for the relatively small effect of each of these **inhibitors** on that fraction on which they had little effect. NADPH was **inhibitory** to etioplast **Protox** activity; however, no **inhibition** was observed on PM **Protox** activity. Quinones such as duroquinone, juglone, or pyrroloquinoline quinone stimulated PM **Protox** activity, whereas lesser or no effects of these quinones were found in etioplasts. The K(m) values for

protoporphyrinogen IX of etioplast and PM **Protox** were 26 and 172 nM, respectively. DTT did not substantially change the K(m) values in either preparation. Diethyldithiocarbamate, a copper chelator, strongly **inhibited** PM activity, while it had little or no effect on etioplast **Protox**. Hydrogen peroxide stimulated PM **Protox** activity, whereas cyanide ion and catalase **inhibited** it. There was much less effect of any of these compounds on etioplast **Protox** activity. These data further substantiate that PM **Protox** is different from etioplast **Protox** and that PM **Protox** is **resistant** to diphenyl ether **herbicides**. Moreover, they suggest that PM **Protox** has characteristics similar to those of a peroxidase.

L7 ANSWER 13 OF 37 AGRICOLA
ACCESSION NUMBER: 95:12583 AGRICOLA
DOCUMENT NUMBER: IND20444506
TITLE: Characterization of oxyfluorfen **tolerance** in selected soybean cell line.
AUTHOR(S): Pornprom, T.; Matsumoto, H.; Usui, K.; Ishizuka, K.
CORPORATE SOURCE: University of Tsukuba, Tsukuba, Ibaraki, Japan
AVAILABILITY: DNAL (SB951.P49)
SOURCE: Pesticide biochemistry and physiology, Oct 1994. Vol. 50, No. 2. p. 107-114
Publisher: Orlando, Fla. : Academic Press.
CODEN: PCBPBS; ISSN: 0048-3575
NOTE: Includes references
PUB. COUNTRY: Florida; United States
DOCUMENT TYPE: Article
FILE SEGMENT: U.S. Imprints not USDA, Experiment or Extension
LANGUAGE: English
AB The mechanism of oxyfluorfen [2-chloro-1-(3-ethoxy-4-nitrophenoxy)-4-(trifluoromethyl) benzene] **tolerance** of a selected nonchlorophyllous soybean cell line was investigated. Light was not required for the growth of the oxyfluorfen-**tolerant** and normal cell lines but was required for the activity of oxyfluorfen. No growth retardation of either cell line by oxyfluorfen was observed under the dark condition. Under light levels higher than 200 microeinsteins m-2 s-2, the growth of normal cells treated with 10(-8) M oxyfluorfen completely stopped; however, no growth retardation of the **tolerant** cells was observed up to 10(-7) M. Determination of protoporphyrin IX (Proto IX) accumulation indicated that the normal cells accumulated a much higher amount of Proto IX in the presence of 5 X 10(-8) and 5 X 10(-6) M oxyfluorfen. However, its accumulation in the **tolerant** cells treated with 5 X 10(-8) M was small. Higher levels of Proto IX were also accumulated in treated cells under the light condition than under the dark condition. This indicates that light acts as an enhancer of the accumulation. The determination of **protoporphyrinogen oxidase** (**Protox**) levels showed that the I50 values of **Protox** activity from the normal and **tolerant** cells were 5 X 10(-10) and 6 X 10(-9) M oxyfluorfen, respectively. **Protox** sensitivity differed by a factor of 12 between normal and **tolerant** cells. This differential **Protox** sensitivity is considered to cause differential levels of Proto IX accumulation. These data suggest that one of the **tolerance** mechanisms of the oxyfluorfen-**tolerant** cells is a decrease in susceptibility of **Protox** to oxyfluorfen.

L7 ANSWER 14 OF 37 AGRICOLA
ACCESSION NUMBER: 95:472 AGRICOLA
DOCUMENT NUMBER: IND20434997
TITLE: Purification and characterization of a protoporphyrinogen-oxidizing enzyme with peroxidase activity and light-dependent **herbicide resistance** in tobacco cultured cells.
AUTHOR(S): Yamato, S.; Katagiri, M.; Ohkawa, H.
CORPORATE SOURCE: Kobe University, Kobe, Japan
AVAILABILITY: DNAL (SB951.P49)
SOURCE: Pesticide biochemistry and physiology, Sept 1994. Vol. 50, No. 1. p. 72-82
Publisher: Orlando, Fla. : Academic Press.
CODEN: PCBPBS; ISSN: 0048-3575
NOTE: Includes references
PUB. COUNTRY: Florida; United States
DOCUMENT TYPE: Article
FILE SEGMENT: U.S. Imprints not USDA, Experiment or Extension
LANGUAGE: English
AB The activity of protoporphyrinogen-oxidizing enzymes was found not only in crude etioplast and mitochondrial fractions but also in the soluble fraction of tobacco cell lines. Approximately 90% of the total activity

was found in the soluble fraction of the SL cell line. A protoporphyrinogen-oxidizing enzyme was purified from the soluble fraction of SL by chromatography on CM-toyopearl, hydroxyapatite, and HA-1000 columns. The purified enzyme has a molecular weight of approximately 48,000 on SDS-polyacrylamide gel electrophoresis. Apparent Km and Vmax values of the purified enzyme for protoporphyrinogen IX were 78.9 micromolar and 1.3 micromoles/mg protein/min, respectively. The purified enzyme utilized uroporphyrinogen I and coproporphyrinogen I as substrates. The protoporphyrinogen-oxidizing activity of the purified enzyme was not **inhibited** by **herbicides** that **inhibit** **protoporphyrinogen oxidase**. The purified enzyme contained a heme and showed peroxidase activity toward guaiacol and pyrogallol. On the other hand, peroxidases commercially available showed the protoporphyrinogen-oxidizing activity. Based on these results, the soluble protoporphyrinogen-oxidizing enzyme in tobacco cultured cells seemed to be a kind of peroxidase. The soluble protoporphyrinogen-oxidizing enzyme with **herbicide resistance** may play an important role in the oxidation of protoporphyrinogen IX which accumulates out of the site of heme and chlorophyll biosynthesis in the **herbicide**-treated plants.

L7 ANSWER 15 OF 37 AGRICOLA
ACCESSION NUMBER: 94:30643 AGRICOLA
DOCUMENT NUMBER: IND20385993
TITLE: Design and synthesis of 1-aryl-4-substituted-1,4-dihydro-5H-tetrazol-5-ones: a novel pre- and postemergence class of **herbicides**.
AUTHOR(S): Theodoridis, G.; Hotzman, F.W.; Scherer, L.W.; Smith, B.A.; Tymonko, J.M.; Wyle, M.J.
AVAILABILITY: DNAL (QD1.A45)
SOURCE: ACS symposium series, 1992. No. 504. p. 122-133
Publisher: Washington, D.C. : American Chemical Society, 1974-
CODEN: ACSMC8; ISSN: 0097-6156
NOTE: In the series analytic: Synthesis and chemistry of agrochemicals III / edited by D.R. Baker, J.G. Fenyes, and J.J. Steffens.
Includes references
PUB. COUNTRY: District of Columbia; United States
DOCUMENT TYPE: Article
FILE SEGMENT: U.S. Imprints not USDA, Experiment or Extension
LANGUAGE: English
AB 1-Aryl-4-substituted-1,4-dihydro-5H-tetrazol-5-ones are a new class of membrane disrupting **herbicides**, which when applied pre- or post-emergence in the presence of light, control several agriculturally *important weed species. The mechanism of action has been found to involve* **inhibition** of **protoporphyrinogen oxidase** which then results in the build-up of a photodynamic toxicant, protoporphyrin IX. An extensive program of activity optimization resulted in the synthesis of compound 1, a **herbicide** with excellent broadleaf weed control and wheat, soybean, and corn **tolerance** when applied preemergence and wheat and corn **tolerance** when applied postemergence. The synthesis, mechanism of action, and *structure-activity relationship of these compounds will be discussed.*

L7 ANSWER 16 OF 37 AGRICOLA
ACCESSION NUMBER: 94:4886 AGRICOLA
DOCUMENT NUMBER: IND20363822
TITLE: Porphyrin accumulation and export by isolated barley (Hordeum vulgare) plastids. Effect of diphenyl ether **herbicides**.
AUTHOR(S): *Jacobs, J.M.; Jacobs, N.J.*
AVAILABILITY: DNAL (450 P692)
SOURCE: Plant physiology, Apr 1993. Vol. 101, No. 4. p. 1181-1187
Publisher: Rockville, MD : American Society of Plant Physiologists, 1926-
CODEN: PLPHAY; ISSN: 0032-0889
NOTE: Includes references
PUB. COUNTRY: Maryland; United States
DOCUMENT TYPE: Article; Conference
FILE SEGMENT: U.S. Imprints not USDA, Experiment or Extension
LANGUAGE: English
AB We have investigated the formation of porphyrin intermediates by isolated barley (Hordeum vulgare) plastids incubated for 40 min with the porphyrin precursor 5-aminolevulinate and in the presence and absence of a diphenylether **herbicide** that blocks **protoporphyrinogen** **oxidase**, the enzyme in chlorophyll and heme synthesis that oxidizes protoporphyrinogen IX to protoporphyrin IX. In the absence of

herbicide, about 50% of the protoporphyrin IX formed was found in the extraplastidic medium, which was separated from intact plastids by centrifugation at the end of the incubation period. In contrast, uroporphyrinogen, an earlier intermediate, and magnesium protoporphyrin IX, a later intermediate, were located mainly within the plastid. When the incubation was carried out in the presence of a **herbicide** that **inhibits protoporphyrinogen oxidase**, protoporphyrin IX formation by the plastids was completely abolished, but large amounts of protoporphyrinogen accumulated in the extraplastidic medium. To detect extraplastidic protoporphyrinogen, it was necessary to first oxidize it to protoporphyrin IX with the use of a **herbicide -resistant protoporphyrinogen oxidase** enzyme present in Escherichia coli membranes. Protoporphyrinogen is not detected by some commonly used methods for porphyrin analysis unless it is first oxidized to protoporphyrin IX. Protoporphyrin IX and protoporphyrinogen found outside the plastid did not arise from plastid lysis, because the percentage of plastid lysis, measured with a stromal marker enzyme, was far less than the percentage of these porphyrins in the extraplastidic fraction. These findings suggest that of the tetrapyrrolic intermediates synthesized by the plastids, protoporphyrinogen and protoporphyrin IX, are the most likely to be exported from the plastid to the cytoplasm. These results help explain the extraplastidic accumulation of protoporphyrin IX in plants treated with photobleaching **herbicides**. In addition, these findings suggest that plastids may export protoporphyrinogen or protoporphyrin IX for mitochondrial heme synthesis.

L7 ANSWER 17 OF 37 AGRICOLA
ACCESSION NUMBER: 94:2452 AGRICOLA
DOCUMENT NUMBER: IND20361237
TITLE: Cellular localization of protoporphyrinogen-oxidizing activities of etiolated barley (Hordeum vulgare L.) leaves. Relationship to mechanism of action of **protoporphyrinogen oxidase-inhibiting herbicides.**
AUTHOR(S): Lee, H.J.; Duke, M.V.; Duke, S.O.
AVAILABILITY: DNAL (450 P692)
SOURCE: Plant physiology, July 1993. Vol. Vol. 102, No. 3. p. 881-889
Publisher: Rockville, MD : American Society of Plant Physiologists, 1926-
CODEN: PLPHAY; ISSN: 0032-0889
NOTE: Includes references
PUB. COUNTRY: Maryland; United States
DOCUMENT TYPE: Article; Conference
FILE SEGMENT: U.S. Imprints not USDA, Experiment or Extension
LANGUAGE: English
AB Seven-day-old, etiolated barley (Hordeum vulgare L. var Post) leaves were fractionated into crude and purified etioplast, microsomal, and plasma membrane (PM) fractions. **Protoporphyrinogen oxidase** (**Protox**) specific activities of crude etioplast, purified etioplasts, microsome, and PM fractions were approximately 29, 26, 23, and 12 nmol h-1 mg-1 of protein, respectively. The **herbicide** acifluorfen-methyl (AFM), at 1 micromolar, **inhibited** **Protox** activity from crude etioplasts, purified etioplasts, microsomes, and PM by 58, 59, 23, and 0% in the absence of reductants. Reductants (ascorbate, glutathione [GSH], dithiothreitol [DTT], and NADPH) individually reduced the **Protox** activity of all fractions, except that microsomal **Protox** activity was slightly stimulated by NADPH. Ascorbate, GSH, or a combination of the two reductants enhanced **Protox inhibition** by AFM, and AFM **inhibition** of **Protox** was greatest in all fractions with DTT. NADPH enhanced AFM **inhibition** significantly only in etioplast fractions. Uroporphyrinogen I (Urogen I) and coproporphyrinogen I (Coprogen I) oxidase activities were found in all fractions; however, etioplast fractions had significantly more substrate specificity for protoporphyrinogen IX (Protogen IX) than the other fractions. Urogen I and Coprogen I oxidase activities were unaffected by AFM in all fractions, and 2 millimole DTT almost completely **inhibited** these activities from all fractions. Diethyldithiocarbamate **inhibited** PM **Protox** activity by 62% but had less effect on microsome and little or no effect on etioplast **Protox**. Juglone and duroquinone stimulated microsomal and PM **Protox** activity, whereas the lesser effect of these quinones on etioplast **Protox** activity was judged to be due to PM and/or microsomal contaminants. These data indicate that there are microsomal and PM Protogen IX-oxidizing activities that are not the same as those associated with the etioplast and that these activities are not **inhibited** in vivo by AFM. In summary, these data support the view that the primary source of high protoporphyrin IX concentrations in AFM-treated plant tissues is from Protogen IX exported by plastids and

oxidized by AFM-**resistant** extraorganellar oxidases.

L7 ANSWER 18 OF 37 AGRICOLA
ACCESSION NUMBER: 92:9251 AGRICOLA
DOCUMENT NUMBER: IND91053396
TITLE: Physiological basis for differential sensitivities of plant species to **protoporphyrinogen oxidase-inhibiting herbicides**.
AUTHOR(S): Sherman, T.D.; Becerril, J.M.; Matsumoto, H.; Duke, M.V.; Jacobs, J.M.; Jacobs, N.J.; Duke, S.O.
CORPORATE SOURCE: USDA, ARS, Southern Weed Science Laboratory, Stoneville, MS
AVAILABILITY: DNAL (450 P692)
SOURCE: Plant physiology, Sept 1991. Vol. 97, No. 1. p. 280-287
Publisher: Rockville, Md. : American Society of Plant Physiologists.
CODEN: PLPHAY; ISSN: 0032-0889
NOTE: Includes references.
DOCUMENT TYPE: Article
FILE SEGMENT: U.S. Imprints not USDA, Experiment or Extension
LANGUAGE: English
AB With a leaf disc assay, 11 species were tested for effects of the **herbicide** acifluorfen on porphyrin accumulation in darkness and subsequent electrolyte leakage and photobleaching of chlorophyll after exposure to light. Protoporphyrin IX (Proto IX) was the only porphyrin that was substantially increased by the **herbicide** in any of the species. However, there was a wide range in the amount of Proto IX accumulation caused by 0.1 millimolar acifluorfen between species. Within species, there was a reduced effect of the **herbicide** in older tissues. Therefore, direct quantitative comparisons between species are difficult. Nevertheless, when data from different species and from tissues of different age within a species were plotted, there was a curvilinear relationship between the amount of Proto IX caused to accumulate during 20 hours of darkness and the amount of electrolyte leakage or chlorophyll photobleaching caused after 6 and 24 hours of light respectively, following the dark period. **Herbicidal** damage plateaued at about 10 nanomoles of Proto IX per gram of fresh weight. Little difference was found between in vitro acifluorfen **inhibition** of **protoporphyrinogen oxidase** (**Protox**) of plastid preparations of mustard, cucumber, and morning glory, three species with large differences in their susceptibility at the tissue level. Mustard, a highly **tolerant** species, produced little Proto IX in response to the **herbicide**, despite having a highly susceptible **Protox**. Acifluorfen blocked carbon flow from delta-aminolevulinic acid to protochlorophyllide in mustard, indicating that it **inhibits Protox** in vivo. Increasing delta-aminolevulinic acid concentrations (33-333 micromolar) supplied to mustard with 0.1 millimolar acifluorfen increased Proto IX accumulation and **herbicidal** activity, demonstrating that mustard sensitivity to Proto IX was similar to other species. Differential susceptibility to acifluorfen of the species examined in this study appears to be due in large part to differences in Proto IX accumulation in response to the **herbicide**. In some cases, differences in Proto IX accumulation appear to be due to differences in activity of the porphyrin pathway.

L7 ANSWER 19 OF 37 CAPLUS COPYRIGHT 2001 ACS
ACCESSION NUMBER: 1998:87475 CAPLUS
DOCUMENT NUMBER: 128:137456
TITLE: Phytotoxicity of **protoporphyrinogen oxidase inhibitors**: phenomenology, mode of action and mechanisms of **resistance**
AUTHOR(S): Dayan, Franck E.; Duke, Stephen O.
CORPORATE SOURCE: National Center for the Development of Natural Products, School of Pharmacy, USDA, ARS, NPURU, University of Mississippi, University, MS, 38677, USA
SOURCE: Rev. Toxicol. (Amsterdam) (1997), 1(3,4), 11-35
CODEN: RETOFJ; ISSN: 1382-6980
PUBLISHER: IOS Press
DOCUMENT TYPE: Journal; General Review
LANGUAGE: English
AB A review with 118 refs. on **protoporphyrinogen oxidase** and on the mode of action and mechanisms of **resistance** of **protoporphyrinogen-oxidase-inhibiting herbicides**.

L7 ANSWER 20 OF 37 CAPLUS COPYRIGHT 2001 ACS
ACCESSION NUMBER: 1998:35357 CAPLUS

DOCUMENT NUMBER: 128:98901
TITLE: Activity of JV 485, a **protoporphyrinogen oxidase inhibitor**, on **herbicide-resistant** black-grass (Alopecurus myosuroides)
AUTHOR(S): Moss, S. R.; Rooke, M. S.
CORPORATE SOURCE: IACR-Rothamsted, Harpenden, Herts, AL5 2JQ, UK
SOURCE: Brighton Crop Prot. Conf.--Weeds (1997), (Vol. 1), 337-342
CODEN: BCPWE2; ISSN: 0955-1514
PUBLISHER: British Crop Protection Council
DOCUMENT TYPE: Journal
LANGUAGE: English
AB Expts. were conducted to det. the efficacy of JV 485, (isopropazol), a new **protoporphyrinogen oxidase** (PPO or **Protox**) **inhibiting herbicide**, on six populations of black-grass (Alopecurus myosuroides) with contrasting **resistance** characteristics. In glasshouse dose response assays, there was no evidence that JV 485 was affected by **resistance**. In an outdoor container expt., JV 485, at 175 g/ha, applied pre-emergence, gave consistently good control (98.8-99.4% redn. in foliage wt.) of all populations. JV 485 gave levels of control at least as good as, and often better than pendimethalin, isoproturon and clodinafop+oil. In a field trial with a heavy infestation of fenoxaprop-**resistant** black-grass (untreated = 1146 heads/m2), pre-emergence applications of JV 485, at 175 g/ha, gave excellent control, achieving a 99% redn. in head nos. JV 485 is not affected by any of the **resistance** mechanisms so far detected in black-grass populations.

L7 ANSWER 21 OF 37 CAPLUS COPYRIGHT 2001 ACS
ACCESSION NUMBER: 1997:706002 CAPLUS
DOCUMENT NUMBER: 128:19369
TITLE: Cloning of plant **protoporphyrinogen oxidase** cDNA and production of transgenic plants **resistant** to light-dependent type **herbicides**
INVENTOR(S): Horikoshi, Mamoru; Hirooka, Takashi
PATENT ASSIGNEE(S): Nihon Nohyaku Co., Ltd., Japan
SOURCE: Jpn. Kokai Tokkyo Koho, 13 pp.
CODEN: JKXXAF
DOCUMENT TYPE: Patent
LANGUAGE: Japanese
FAMILY ACC. NUM. COUNT: 1
PATENT INFORMATION:

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
JP 09275986	A2	19971028	JP 1996-113295	19960410

AB The cDNA encoding **protoporphyrinogen oxidase** is isolated from Arabidopsis thaliana strain Columbia gl1 and its amino acid sequence deduced (508 amino acids). The cDNA can be used for breeding transgenic plants that are **resistant** to light-dependent type **herbicides**. Also claimed are the mutagenized cDNAs and their protein products, and methods for the recombinant prepn. of **protoporphyrinogen oxidase**.

L7 ANSWER 22 OF 37 CAPLUS COPYRIGHT 2001 ACS
ACCESSION NUMBER: 1997:332482 CAPLUS
DOCUMENT NUMBER: 126:303835
TITLE: **Herbicide-tolerant** transgenic plants expressing **protoporphyrinogen oxidase**
INVENTOR(S): Yun, Young-Chae; Moon, Young-Ho; Choi, Jin-Nam; Choi, Kyu-Whan; Kim, Chul-Hwan; Kim, Man-Keun; Guh, Ja-Ock; Jeon, Hong-Seob
PATENT ASSIGNEE(S): Jinro Limited, S. Korea
SOURCE: Eur. Pat. Appl., 14 pp.
CODEN: EPXXDW
DOCUMENT TYPE: Patent
LANGUAGE: English
FAMILY ACC. NUM. COUNT: 1
PATENT INFORMATION:

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
EP 770682	A2	19970502	EP 1996-400089	19960115
EP 770682	A3	19971126		
R: BE, CH, DE, FR, GB, LI, NL				
CA 2167228	AA	19970412	CA 1996-2167228	19960115

JP 09107833 A2 19970428 JP 1996-63016 19960319
PRIORITY APPLN. INFO.: KR 1995-34790 19951011

AB The present invention provides a **herbicide-tolerant** transgenic plant producing **Protox** (**protoporphyrinogen oxidase**) which gives the plant a **resistance** against DPE(diphenylether) -derived **herbicide**, and a process for prepg. the same. The process for prepg. a **herbicide-tolerant** transgenic plant comprises the step of culturing plant cells transformed with a recombinant expression vector contg. **Protox** gene. Transgenic tobacco expressing Bacillus subtilus **Protox** were prepd. using Agrobacterium tumefaciens contg. plasmid pBP14, which contains the **Protox** gene controlled by the cauliflower mosaic virus 35S promoter. The leaves of these transgenic plants displayed enhanced **resistance** to decolorization by oxyfluorfen.

L7 ANSWER 23 OF 37 CAPLUS COPYRIGHT 2001 ACS
ACCESSION NUMBER: 1996:690153 CAPLUS
DOCUMENT NUMBER: 126:2992
TITLE: Protoporphyrinogen destruction Protoporphyrinogen destruction by plant extracts and correlation with **tolerance** to **protoporphyrinogen oxidase-inhibiting herbicides**
AUTHOR(S): Jacobs, Judith M.; Jacobs, Nicholas J.; Duke, Stephen O.
CORPORATE SOURCE: Dep. Microbiol., Dartmouth Med. Sch., Hannover, NH, 003755-3842, USA
SOURCE: Pestic. Biochem. Physiol. (1996), 55(1), 77-83
CODEN: PCBPBS; ISSN: 0048-3575
PUBLISHER: Academic
DOCUMENT TYPE: Journal
LANGUAGE: English

AB **Herbicidal** damage by photobleaching di-Ph ether **herbicides** is the indirect result of **inhibition** of an enzyme in chlorophyll biosynthesis. The substrate of the **inhibited** enzyme, protoporphyrinogen, accumulates and is subsequently converted to protoporphyrin, a potent photoactive compd. which causes light-dependent membrane damage. We report characteristics of a factor in the sol. fraction of leaves which can decomp. protoporphyrinogen to nonporphyrin products. This process may be important in protecting plants from **herbicide** damage, since it would interfere with accumulation of the phototoxic porphyrin, protoporphyrin. This protoporphyrinogen destruction is assocd. with the protein fraction of the sol. leaf homogenate, suggesting its enzymic nature. Protoporphyrinogen destruction is stable to mild heat, but is eliminated by boiling. Protoporphyrinogen destruction is present in the sol. leaf homogenate but is not localized within the stromal fraction of the chloroplast. The reductants dithiothreitol and .beta.-mercaptoethanol, but not glutathione, **inhibit** protoporphyrinogen destruction at high concns. Ascorbic acid **inhibits** destruction, even at low concns., suggesting a role for cellular ascorbic acid in protecting protoporphyrinogen from destruction, thereby enhancing **herbicide** action. Protoporphyrinogen destruction was least active in young cucumber leaves, a plant highly susceptible to **herbicides**. Higher levels of protoporphyrinogen destruction were found in leaves of broadleaf mustard and radish, two plants exhibiting **herbicide tolerance**. For cucumber, the extent of destruction increased with the age of the plant. These findings suggest a correlation between increased protoporphyrinogen destruction and **herbicide tolerance** in some plant species.

L7 ANSWER 24 OF 37 CAPLUS COPYRIGHT 2001 ACS
ACCESSION NUMBER: 1996:265591 CAPLUS
DOCUMENT NUMBER: 125:79315
TITLE: Accumulation of protoporphyrinogen IX induced by acifluorfen methyl
AUTHOR(S): Sumida, Motoo; Niwata, Shinjiro; Tanaka, Takaharu; Furuno, Tadahide; Nakanishi, Mamoru; Wakabayashi, Ko; Boeger, Peter
CORPORATE SOURCE: Inst. Biomed. Res., Suntory Limited, Osaka, 618, Japan
SOURCE: Z. Naturforsch., C: Biosci. (1996), 51(3/4), 174-8
CODEN: ZNCBDA; ISSN: 0341-0382
DOCUMENT TYPE: Journal
LANGUAGE: English

AB Confocal fluorescence microscopic images were used to investigate the accumulation site of protoporphyrin IX (PPIX) within liverwort cells (Marchantia polymorpha) treated with the peroxidizing **herbicide** acifluorfen Me (AFM). A high level of PPIX accumulation was obsd. in the cells during 12-24 h after the addn. of AFM. The results obtained from

confocal fluorescence microscopic images gave clear evidence that the accumulation of PPIX occurred only in the chloroplasts, but was not obsd. in the cytosol or at the plasma membrane. The presence of PPIX in the chloroplasts strongly suggests that protoporphyrinogen (Protogen) accumulates by **inhibition** of **protoporphyrinogen oxidase** (**Protox**) which is the target enzyme for peroxidizing **herbicides**. The plastidic occurrence of PPIX provides evidence of either the presence of an addnl. **herbicide-resistant Protox** or of a non-enzymic Protogen-oxidn. system in the Marchantia chloroplast.

L7 ANSWER 25 OF 37 CAPLUS COPYRIGHT 2001 ACS
ACCESSION NUMBER: 1996:50114 CAPLUS
DOCUMENT NUMBER: 124:79389
TITLE: Cross-**tolerance** of oxyfluorfen-**tolerant** soybean cells to **protoporphyrinogen oxidase-inhibiting herbicides**.
AUTHOR(S): Usui, Kenji; Pornprom, Tosapon; Matsumoto, Hiroshi; Shirakura, Shinichi; Ishizuka, Kozo
CORPORATE SOURCE: Inst. Appl. Biochem., Univ. Tsukuba, Tsukuba, 305, Japan
SOURCE: Zasso Kenkyu (1995), 40(3), 187-93
CODEN: ZASKAN; ISSN: 0372-798X
DOCUMENT TYPE: Journal
LANGUAGE: English
AB Characterization of cross-**tolerance** of selected oxyflurfen-**tolerant** and nonselected (normal) soybean cell lines to **protoporphyrinogen oxidase** (**Protox**)-**inhibiting herbicides** (oxyfluorfen, bifenox, nitrofen, and oxadiazon) or acetolactate synthetase-**inhibiting herbicide** (bensulfuron methyl) was detd. The sensitivities of both cell types to oxyfluorfen were compared by detn. of the growth rates and target enzyme **inhibition** using various **Protox-inhibiting herbicides**. On the I50 values of growth, the **tolerant** cells showed about 100-, 200-, 5000-, and >30,000-fold more **tolerance** than the normal cells to oxyfluorfen, oxadiazon, bifenox, and nitrofen, resp. The cells were found to have cross-**tolerance** to all **Protox-inhibiting herbicides** tested, however, a lack of cross-**tolerance** to bensulfuron Me was obsd. Detn. of the **inhibition** on **Protox** activity showed that the sensitivity of the enzyme prepns. between the two cell types differed about 15-fold to oxyfluorfen, 30-fold to oxadiazon, 45-fold to bifenox, and 100-fold to nitrofen. There was a pos. correlation between the **tolerance** ratio detd. by growth rate and that at the enzyme level.

L7 ANSWER 26 OF 37 CAPLUS COPYRIGHT 2001 ACS
ACCESSION NUMBER: 1995:837406 CAPLUS
DOCUMENT NUMBER: 123:251596
TITLE: Selection and characterization of **protoporphyrinogen oxidase inhibiting herbicide** (S23142) **resistant** photomixotrophic cultured cells of Nicotiana tabacum
AUTHOR(S): Ichinose, Katsunori; Che, Fang-Sik; Kimura, Yukio; Matsunobu, Atsuko; Sato, Fumihiko; Yoshida, Shigeo
CORPORATE SOURCE: Inst. Phys. Chem. Res. (RIKEN), Saitama, 351-01, Japan
SOURCE: J. Plant Physiol. (1995), 146(5/6), 693-8
CODEN: JPPHEY; ISSN: 0176-1617
DOCUMENT TYPE: Journal
LANGUAGE: English
AB S23142 and acifluorfen-Et (AFE) **inhibit** **protoporphyrinogen oxidase** (**Protox**) and induce accumulation of protoporphyrin IX (Proto IX) which is a strong phytotoxic photosensitizer. A S23142-**resistant** cell line, YZI-1S, of photomixotrophically cultured tobacco was selected and its **resistance** mechanism was characterized. While growth rates of wild-type and YZI-1S cells were similar in the absence of the **herbicide**, S23142 concns. that reduced the chlorophyll contents by 50% were 2 and 250 nM for wild-type and YZI-1S cell lines, resp. The YZI-1S cells also exhibited **resistance** for other types of **Protox inhibiting herbicides** (acifluorfenethyl, acifluorfen, bifenox, oxadiazon, chlomethoxynil, nitrofen and chlornitrofen), but were sensitive to atrazine and DCMU, which **inhibit** photosynthetic electron transport. YZI-1S cells did not accumulate Proto IX, even at 100 nM S23142 in which the wild-type cells accumulated large amts. of Proto IX. **Protox** isolated from YZI-1S cells showed a 2-fold higher activity than that of wild-type cells

and also exhibited a 20-fold increase in **tolerance** to S23142. On the other hand, treatment with 1 mM .delta.-Aminolevulinic acid (ALA), a tetrapyrrole precursor, induced photobleaching by accumulation of Proto IX in both YZI-1S and wild-type cells under high light irradn. Thus, the **resistance** of YZI-1S cells to S23142 is due mainly to the increase of **Protox** activity.

L7 ANSWER 27 OF 37 CAPLUS COPYRIGHT 2001 ACS
ACCESSION NUMBER: 1994:501820 CAPLUS
DOCUMENT NUMBER: 121:101820
TITLE: F8426 - a new, rapidly acting, low rate **herbicide** for the post-emergence selective control of broad-leaved weeds in cereals
AUTHOR(S): Van Saun, W. A.; Bahr, J. T.; Bourdouxhe, L. J.; Gargantiel, F. J.; Hotzman, F. W.; Shires, S. W.; Sladen, N. A.; Tutt, S. F.; Wilson, K. R.
CORPORATE SOURCE: Agric. Chem. Group, FMC Corp., Princeton, NJ, 08543, USA
SOURCE: Brighton Crop Prot. Conf.--Weeds (1993), (VOL. 1), 19-28
CODEN: BCPWE2; ISSN: 0955-1514
DOCUMENT TYPE: Journal
LANGUAGE: English
AB F8426, is a new selective cereal **herbicide**. It is an **inhibitor** of **protoporphyrinogen oxidase**. Applied post-emergence, F8426 results in rapid desiccation of sensitive weed species. Translocation is limited. Field testing over several years in the United States, the United Kingdom, France, Germany, the Philippines, Australia, and selected other countries, indicates that F8426 will control a wide range of broad-leaved weeds with good **tolerance** to wheat, barley, and rice. In Europe, F8426 is esp. effective against Galium aparine, Lamium purpureum, and Veronica spp. In the U.S., it is effective against most major broad-leaved weeds in wheat, including Kochia scoperia, Salsola kali, Chenopodium album, Amaranthus retroflexus, and a wide range of winter annual mustards.

L7 ANSWER 28 OF 37 CAPLUS COPYRIGHT 2001 ACS
ACCESSION NUMBER: 1993:645957 CAPLUS
DOCUMENT NUMBER: 119:245957
TITLE: Isolation and characterization of a Chlamydomonas reinhardtii mutant **resistant** to an experimental **herbicide** S-23142, which **inhibits** chlorophyll synthesis
AUTHOR(S): Shibata, Hideyuki; Yamamoto, Masako; Sato, Ryo; Harris, Elizabeth H.; Gillham, Nicholas W.; Boynton, John E.
CORPORATE SOURCE: Takarazuka Res. Cent., Sumitomo Chem. Co. Ltd., Takarazuka, 665, Japan
SOURCE: Res. Photosynth., Proc. Int. Congr. Photosynth., 9th (1992), Volume 3, 567-70. Editor(s): Murata, Norio. Kluwer: Dordrecht, Neth.
CODEN: 59IZA5
DOCUMENT TYPE: Conference
LANGUAGE: English
AB A mutant of Chlamydomonas reinhardtii rs-3 was isolated from a wild type strain CC-407. The rs-3 mutant shows 100 fold **resistance** to an exptl. **herbicide** S-23142 [N-(4-chloro-2-fluoro-5-propargyloxy)-phenyl-3,4,5,6-tetrahydrophthalimide] which **inhibits** the **protoporphyrinogen oxidase** (Proto-ox) in the chlorophyll synthesis pathway and induces massive accumulation of porphyrins in cells. Repeated backcrosses of rs-3 to wild type stocks CC-124 and CC-125 yielded tetrads which segregated two **herbicide** sensitive and two **resistant** products, indicating that **resistance** results from a mutation in the nuclear genome. Synthesis of protoporphyrin IX from protoporphyrinogen in isolated chloroplast fragments from rs-3 is significantly less **inhibited** by S-23142 than in CC-407, indicating that the rs-3 mutation affects Proto-ox. Anal. of rs-3 arg-2/+ arg-7 diploids shows that the rs-3 mutation is dominant at the levels of both cell viability and Proto-ox enzyme **resistance**.

L7 ANSWER 29 OF 37 CAPLUS COPYRIGHT 2001 ACS
ACCESSION NUMBER: 1993:511157 CAPLUS
DOCUMENT NUMBER: 119:111157
TITLE: Mode of action of light-dependent **herbicide**
AUTHOR(S): Che, Fang Sik; Ichinose, Katsunori; Takemura, Yoko; Yoshida, Shigeo
CORPORATE SOURCE: Inst. Phys. Chem. Res., Wako, 351-01, Japan
SOURCE: Proc. Plant Growth Regul. Soc. Am. (1992), 19th, 227-30

CODEN: PPGRDG; ISSN: 0731-1664
DOCUMENT TYPE: Journal
LANGUAGE: English
AB The light dependent **herbicides** (LDH) such as S-23142 and acifluorfen-Et **inhibit protoporphyrinogen oxidase** (PPO). The **herbicidal** action of the chem. has been deduced to the accumulation of a phytotoxic photosensitizer, protoporphyrin IX (Proto IX). In order to investigate the mode of action of LDH, photomixotrophic cultures tobacco cells were selected for **tolerance** to S-23142. Selected cell line grew on medium contg. 200 nM S-23142. While effect of LDH on protoporphyrin biosynthesis in chloroplasts was examd. using HPLC with fluorescence monitoring. Proto IX biosynthesis was detected in isolated chloroplasts and also **inhibited** by 10-9M of S-23142. However, the Proto IX synthesis in the LDH **tolerant** cells was unaffected under the same concn. of S-23142. Thus, **tolerance** mutation is assocd. with the **protoporphyrinogen oxidase**. In addn., activity of the biosynthesis and sensitivity of LDH were obsd. only in the stroma fraction of chloroplasts, indicating that a target-site of LDH existed in stroma fraction.

L7 ANSWER 30 OF 37 CAPLUS COPYRIGHT 2001 ACS
ACCESSION NUMBER: 1993:443282 CAPLUS
DOCUMENT NUMBER: 119:43282
TITLE: Localization of target-site of the **protoporphyrinogen oxidase-inhibiting herbicide**, S-23142, in Spinacia oleracea L.
AUTHOR(S): Che, Fang Sik; Takemura, Yoko; Suzuki, Naoko; Ichinose, Katsunori; Wang, Jim Ming; Yoshida, Shigeo
CORPORATE SOURCE: Inst. Phys. Chem. Res., Wako, 351-01, Japan
SOURCE: Z. Naturforsch., C: Biosci. (1993), 48(3-4), 350-5
CODEN: ZNCBDA; ISSN: 0341-0382
DOCUMENT TYPE: Journal
LANGUAGE: English
AB Effects of S-23142 on protoporphyrin IX (Proto IX) biosynthesis in chloroplasts isolated from Spinacia oleracea L. were examd. using reverse phase HPLC with fluorescence monitoring. The synthesis of Proto IX was **inhibited** to a level of 50% by 10-9 M of S-23142 in this system. The effect of S-23142 was also tested in chloroplasts isolated from two types of photomixotrophic tobacco cells, wild type and S-23142 **tolerant** cells. The biosynthesis of both the wild type cells and YZI-1 S cells was **inhibited** at 50% by 10-9 M and 10-7 M of S-23142, resp. Thus, the mutation in the **tolerant** cell is assocd. with the **Protox**. To investigate the localization of Proto IX biosynthesis and the target site of S-23142, spinach chloroplasts were osmotically broken and sepd. into stroma and membrane (thylakoid and envelope) fractions. A very active Proto IX synthesis from ALA was found in the stromal fraction, while no activity of Proto IX synthesis was obsd. in the membrane fraction. Apparently, most Proto IX synthetic activity and a target-site of S-23142 exist in the stromal fraction.

L7 ANSWER 31 OF 37 CAPLUS COPYRIGHT 2001 ACS
ACCESSION NUMBER: 1993:443212 CAPLUS
DOCUMENT NUMBER: 119:43212
TITLE: Isolation of characterization of a Chlamydomonas reinhardtii mutant **resistant** to photobleaching **herbicides**
AUTHOR(S): Oshio, Hiromichi; Shibata, Hideyuki; Mito, Nobuaki; Yamamoto, Masako; Harris, Elizabeth H.; Gillham, Nicholas W.; Boynton, John E.; Sato, Ryo
CORPORATE SOURCE: Takarazuka Res. Cent., Sumitomo Chem. Co. Ltd., Takarazuka, 665, Japan
SOURCE: Z. Naturforsch., C: Biosci. (1993), 48(3-4), 339-44
CODEN: ZNCBDA; ISSN: 0341-0382
DOCUMENT TYPE: Journal; General Review
LANGUAGE: English
AB A review with 21 refs. of the mode of action of N-phenylimide photobleaching **herbicides** in comparison with di-Ph ether **herbicides**. These N-phenylimide **herbicides** as well as di-Ph ether **herbicides** induce protoporphyrin IX accumulation and **inhibit protoporphyrinogen oxidase** activity at extremely low concns. in higher plants. The binding of a 14C-labeled N-phenylimide **herbicide** S-23121 [N-[4-chloro-2-fluoro-5-[(1-methyl-2-propynyl)oxy]phenyl]-3,4,5,6-tetrahydrophthalimide] to the solubilized plastid fractions of greening corn seedlings is competed by the di-Ph ether **herbicide** acifluorfen-Et, but not by diuron, an **inhibitor** of photosynthetic electron transport. These results indicate a similar mode of action for both N-phenylimide and di-Ph ether

herbicides. In order to investigate the mechanism of photobleaching **herbicides** at the mol. level, a strain of Chlamydomonas reinhardtii RS-3 **resistant** to N-phenylimide S-23142 [N-(4-chloro-2-fluoro-5-propargyloxyphenyl)-3,4,5,6-tetrahydrophthalimide] was isolated by mutagenesis with N-methyl-N'-nitro-N-nitrosoguanidine. The 90% **inhibition** concn. of N-phenylimide S-23142 for growth of RS-3 was 100 times higher than that for wild type. Max. accumulation of protoporphyrin IX was reached at 0.03 .mu.M of S-23142 for the wild type and 3 .mu.M for RS-3. RS-3 was **resistant** to oxadiazon, oxyfluorfen and acifluorfen-Et which had been shown to have the same mechanism of action as N-phenylimide **herbicides**, but not to paraquat, diuron or fluridone. Genetic anal. of RS-3 strain showed that the **resistance** results from a dominant mutation (rs-3) in the nuclear genome. The magnesium protoporphyrin IX synthesizing activity from 5-aminolevulinic acid in chloroplast fragments isolated from RS-3 was less sensitive to S-23142 than that from wild type (CC-407). **Protoporphyrinogen oxidase** activity in Percoll-purified chloroplasts from RS-3 was also less sensitive to S-23142 than that from wild type. Thus, the **resistance** of RS-3 is specific for photobleaching **herbicides**, and the mutation is related to **protoporphyrinogen oxidase**, the primary site of the photobleaching **herbicide** action.

L7 ANSWER 32 OF 37 BIOSIS COPYRIGHT 2001 BIOSIS
ACCESSION NUMBER: 1998:189830 BIOSIS
DOCUMENT NUMBER: PREV199800189830
TITLE: Activity of JV 485, a **protoporphyrinogen oxidase inhibitor**, on **herbicide -resistant** black-grass (Alopecurus myosuroides.
AUTHOR(S): Moss, S. R. (1); Rooke, M. S.
CORPORATE SOURCE: (1) IACR-Rothamsted, Harpenden, Herts. AL5 2JQ UK
SOURCE: BRITISH CROP PROTECTION COUNCIL.. (1997) pp. 337-342. The 1997 Brighton crop protection conference: Weeds, Vols. 1-3. Publisher: British Crop Protection Council (BCPC) 49 Downing Street, Farnham GU9 7PH, England. Meeting Info.: International Conference Brighton, England, UK November 17-20, 1997 British Crop Protection Council . ISBN: 1-901396-45-2 (set), 1-901396-46-0 (Vol. 1), 1-901396-47-9 (Vol. 2), 1-901396-48-7 (Vol. 3).
DOCUMENT TYPE: Book; Conference
LANGUAGE: English

L7 ANSWER 33 OF 37 BIOSIS COPYRIGHT 2001 BIOSIS
ACCESSION NUMBER: 1998:189794 BIOSIS
DOCUMENT NUMBER: PREV199800189794
TITLE: Overview of **protoporphyrinogen oxidase-inhibiting herbicides**.
AUTHOR(S): Dayan, F. E. (1); Duke, S. O.
CORPORATE SOURCE: (1) U.S. Dep. Agric., Agric. Res. Serv., Nat. Products Utilization Res. Unit, Natl. Cent. Dev. Nat. Products, P.O. Box 8048, University, MS 38677 USA
SOURCE: BRITISH CROP PROTECTION COUNCIL.. (1997) pp. 83-92. The 1997 Brighton crop protection conference: Weeds, Vols. 1-3. Publisher: British Crop Protection Council (BCPC) 49 Downing Street, Farnham GU9 7PH, England. Meeting Info.: International Conference Brighton, England, UK November 17-20, 1997 British Crop Protection Council . ISBN: 1-901396-45-2 (set), 1-901396-46-0 (Vol. 1), 1-901396-47-9 (Vol. 2), 1-901396-48-7 (Vol. 3).
DOCUMENT TYPE: Book; Conference
LANGUAGE: English

L7 ANSWER 34 OF 37 BIOSIS COPYRIGHT 2001 BIOSIS
ACCESSION NUMBER: 1993:527555 BIOSIS
DOCUMENT NUMBER: PREV199396140962
TITLE: The physiological basis of **resistance** to the dicarboximide fungicide iprodione in Botrytis cinerea.
AUTHOR(S): Steel, Christopher C.; Nair, N. G.
CORPORATE SOURCE: N.S.W. Dep. Agriculture, Biological Chemical Res. Inst., Private Mail Bag 10, Rydalmere, NSW 2116 Australia
SOURCE: Pesticide Biochemistry and Physiology, (1993) Vol. 47, No. 1, pp. 60-68. ISSN: 0048-3575.
DOCUMENT TYPE: Article
LANGUAGE: English
AB A dicarboximide-sensitive and a dicarboximide-**resistant** isolate of Botrytis cinerea from grape vines took up radio labeled iprodione to the same extent. Thin-layer chromatographic analysis of extracts from

(14C)iprodione-incubated mycelium indicated that neither isolate metabolized the fungicide. **Inhibition** of fungal growth by the decarboximide fungicides iprodione, vinclozolin, and procymidone could be reversed by the inclusion of the free radical scavenger alpha-tocopherol in the medium, suggesting that the mode of action of the dicarboximides is dependent upon free radical formation. However, this effect was also seen with the chemically unrelated fungicides fenpropimorph and propiconazole but not with benomyl. The level of lipid peroxides and the activity of superoxide dismutase were similar in both isolates; however, the **resistant** isolate had a significantly greater activity of catalase. **Resistance** to the dicarboximide fungicide iprodione in B. cinerea is not therefore mediated by differences in the uptake and subsequent metabolism of the fungicide but may be based on altered levels of enzymes responsible for the detoxification of peroxy radicals.

L7 ANSWER 35 OF 37 BIOSIS COPYRIGHT 2001 BIOSIS
ACCESSION NUMBER: 1993:472448 BIOSIS
DOCUMENT NUMBER: PREV199345095573
TITLE: Mechanisms of plant **tolerance** to phytodynamic **herbicides**.
AUTHOR(S): Komives, T.; Gullner, G.
CORPORATE SOURCE: Plant Protection Inst., Hung. Acad. Sci., P. O. Box 102, H-1525 Budapest Hungary
SOURCE: Abstracts of Papers American Chemical Society, (1993) Vol. 206, No. 1-2, pp. AGRO 128.
Meeting Info.: 206th ACS (American Chemical Society) National Meeting Chicago, Illinois, USA August 22-27, 1993
ISSN: 0065-7727.
DOCUMENT TYPE: Conference
LANGUAGE: English

L7 ANSWER 36 OF 37 BIOSIS COPYRIGHT 2001 BIOSIS
ACCESSION NUMBER: 1993:472432 BIOSIS
DOCUMENT NUMBER: PREV199345095557
TITLE: Characterization of a mutant of Chlamydomonas reinhardtii **resistant** to **Protox inhibitors**.
AUTHOR(S): Sato, R. (1); Yamamoto, M.; Shibata, H.; Oshio, H.; Harris, E. H. (1); Gillham, N. W. (1); Boynton, J. E. (1)
CORPORATE SOURCE: (1) Dep. Botany Zool., Duke Univ., Box 90338, Durham, NC 27708-0338 USA
SOURCE: Abstracts of Papers American Chemical Society, (1993) Vol. 206, No. 1-2, pp. AGRO 112.
Meeting Info.: 206th ACS (American Chemical Society) National Meeting Chicago, Illinois, USA August 22-27, 1993
ISSN: 0065-7727.
DOCUMENT TYPE: Conference
LANGUAGE: English

L7 ANSWER 37 OF 37 WPIDS COPYRIGHT 2001 DERWENT INFORMATION LTD
ACCESSION NUMBER: 1997-344895 [32] WPIDS
DOC. NO. CPI: C1997-110901
TITLE: New proto-porphyrinogen oxidase gene used in production of porphyrin - is derived from Arabidopsis thaliana.
DERWENT CLASS: C06 D16
PATENT ASSIGNEE(S): (SUMO) SUMITOMO CHEM CO LTD
COUNTRY COUNT: 1
PATENT INFORMATION:

PATENT NO	KIND	DATE	WEEK	LA	PG
JP 09140381	A	19970603	(199732)*		6

APPLICATION DETAILS:

PATENT NO	KIND	APPLICATION	DATE
JP 09140381	A	JP 1995-301054	19951120

PRIORITY APPLN. INFO: JP 1995-301054 19951120
AN 1997-344895 [32] WPIDS
AB JP 09140381 A UPAB: 19970806
Proto-porphyrinogen oxidase gene comprises a gene of 1.7 kbp in length derived from Arabidopsis thaliana and having a nucleotide sequence of 5'-GAATCC-3' (recognised by a restriction enzyme EcoRI) located at a site apart by 1.3 kbp from the 5'-terminal. Also claimed are a plasmid containing the **protoporphyrinogen oxidase** gene; a microorganism carrying the plasmid; plant cells carrying the plasmid; and a plant transformed by introducing the **protoporphyrinogen**

oxidase gene into plant cells.

The gene of the invention is obtained by extracting whole RNA from leaves or stems of Arabidopsis thaliana cDNA is synthesised from poly (A) RNA from the RNA to prepare a cDNA library. The cDNA library is amplified and transformed into E. coli. The microorganism is culture din a medium in which only a transformant expressing **protoporphyrinogen oxidase** can survive, and the positive clones are selected to give cDNA for **protoporphyrinogen oxidase**.

USE - The gene is used to produce **protoporphyrinogen oxidase** which is an enzymes participating in production of porphyrin.

ADVANTAGE - By artificially reinforcing porphyrin biosynthesis by means of the gene for **protoporphyrinogen oxidase** involved in biosynthesis of porphyrin, a plant variety having an improved photosynthetic ability and **resistance** to light requiring **herbicides** can be bred to produce larger products.

Dwg.0/3

IUBMB Enzyme Nomenclature

EC 1.3.3.4

Recommended name: protoporphyrinogen oxidase

Reaction: protoporphyrinogen-IX + O_2 = protoporphyrin-IX + H_2O

Other name(s): protoporphyrinogenase; protoporphyrinogen IX oxidase

Systematic name: protoporphyrinogen-IX:oxygen oxidoreductase

Comments: Also slowly oxidizes mesoporphyrinogen-IX.

Links to other databases: BRENDA, EXPASY, KEGG, WIT, CAS registry number: 53986-32-6

References:

1. Poulson, R. The enzymic conversion of protoporphyrinogen IX to protoporphyrin IX in mammalian mitochondria. *J. Biol. Chem.* 251 (1976) 3730-3733. [Medline UI: 76213227]

2. Poulson, R. and Polglase, W.J. The enzymic conversion of protoporphyrinogen IX to protoporphyrin IX. Protoporphyrinogen oxidase activity in mitochondrial extracts of *Saccharomyces cerevisiae*. *J. Biol. Chem.* 250 (1975) 1269-1274. [Medline UI: 75095591]

[EC 1.3.3.4 created 1978]

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